



# CS 540 Introduction to Artificial Intelligence Course Overview

University of Wisconsin-Madison

Fall 2022

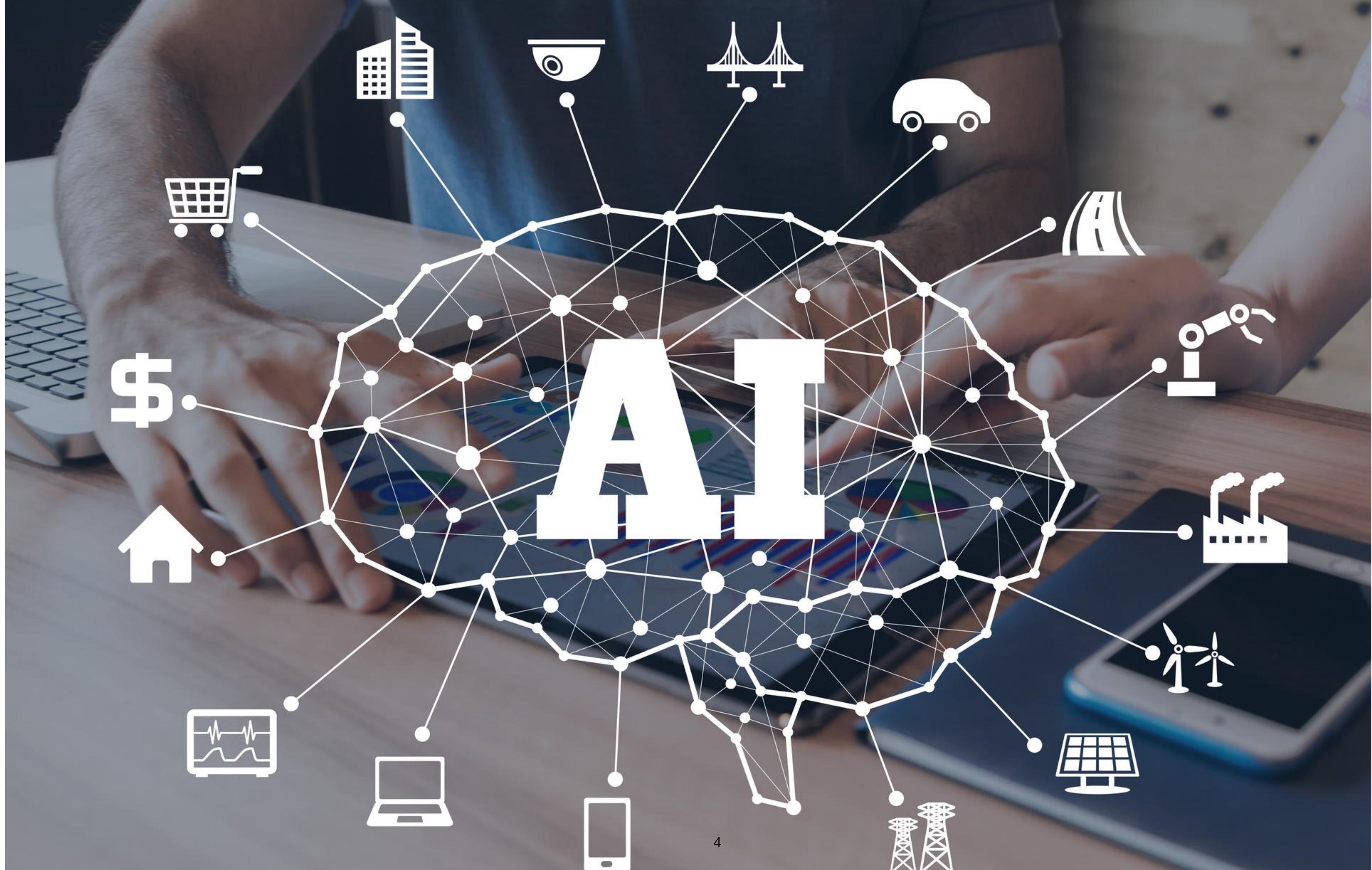


# Today's outline

- What's in CS540
- Course logistics
- Software



# Part I: Course overview



# Classify Images

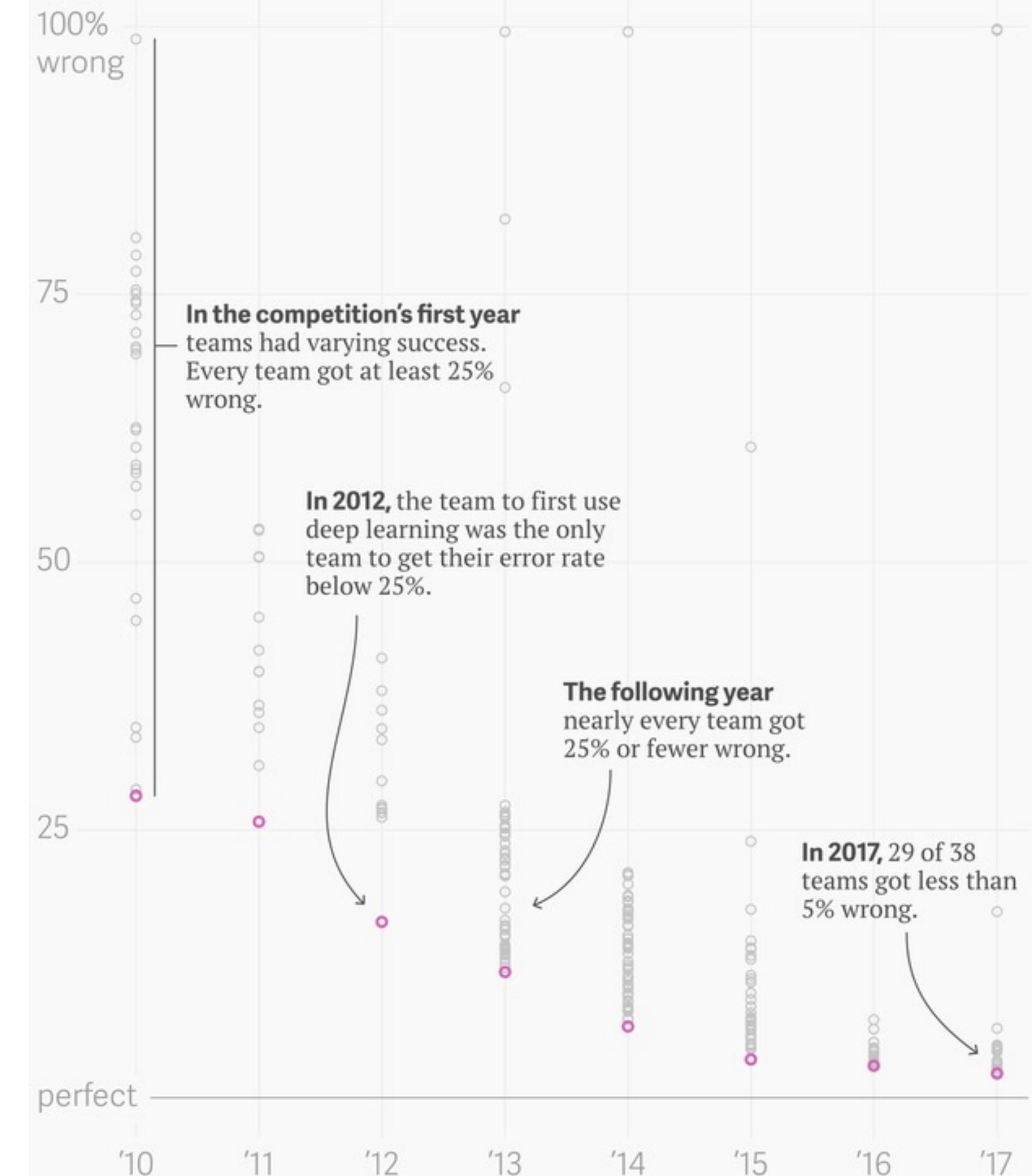
<http://www.image-net.org/>



# Classify Images



ImageNet Large Scale Visual Recognition Challenge results



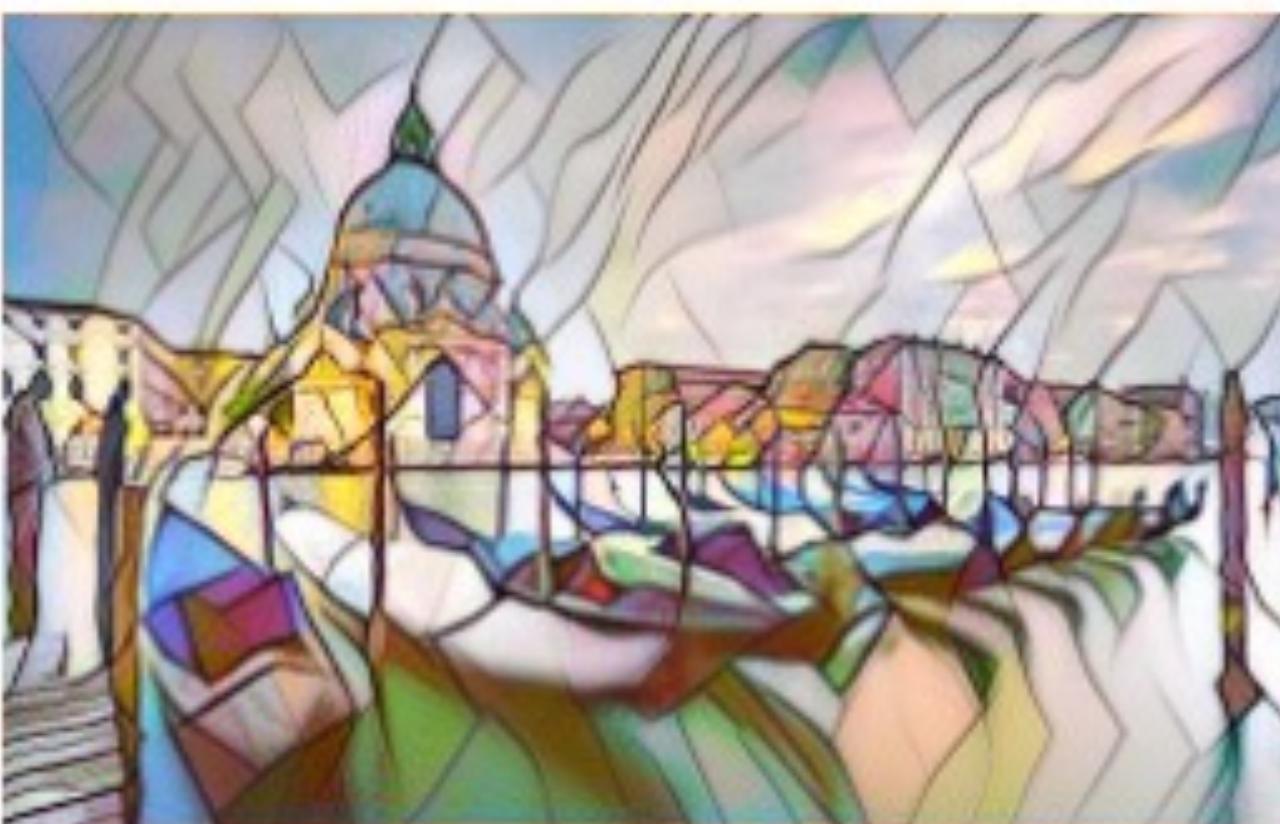
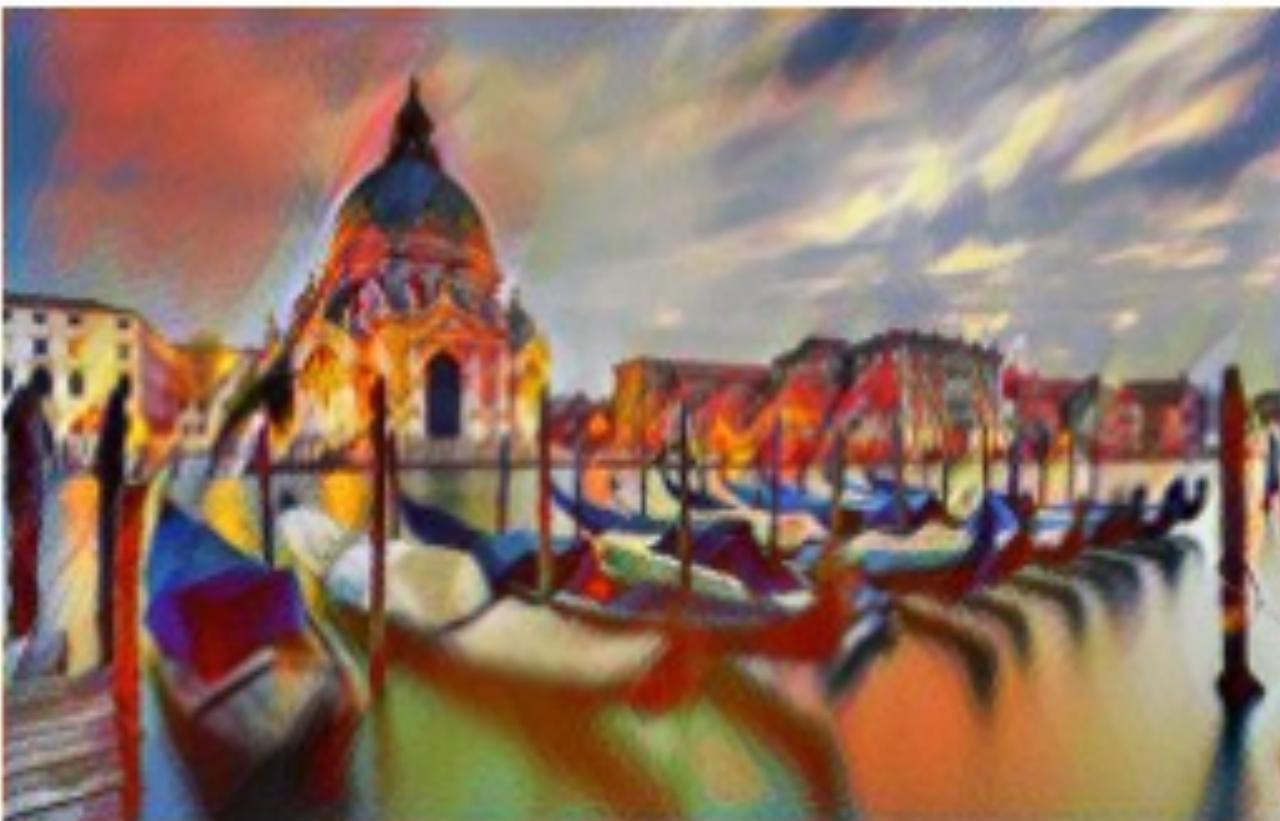
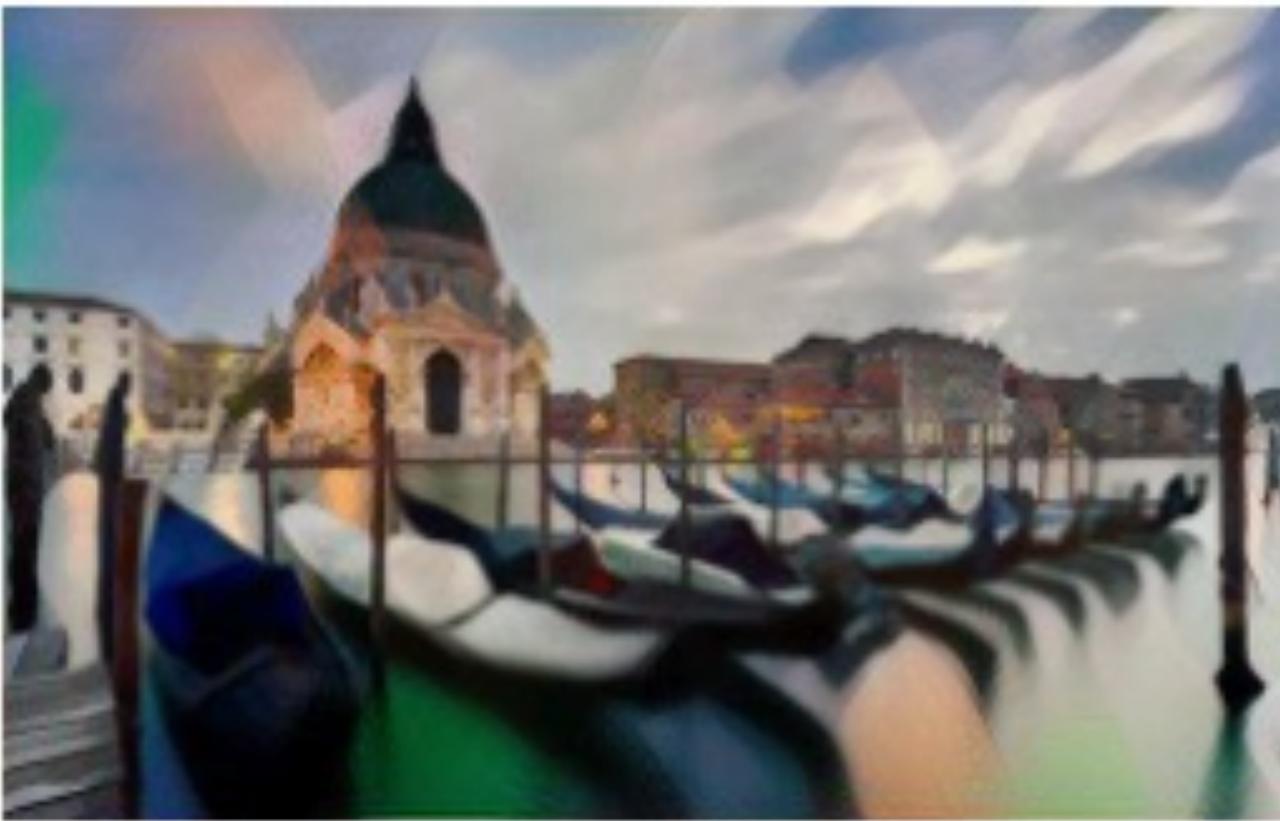
# Detect and Segment Objects



[https://github.com/matterport/Mask\\_RCNN](https://github.com/matterport/Mask_RCNN)

# Style Transfer

<https://github.com/StacyYang/MXNet-Gluon-Style-Transfer>



# Generative Modeling

4.5 years of face generation



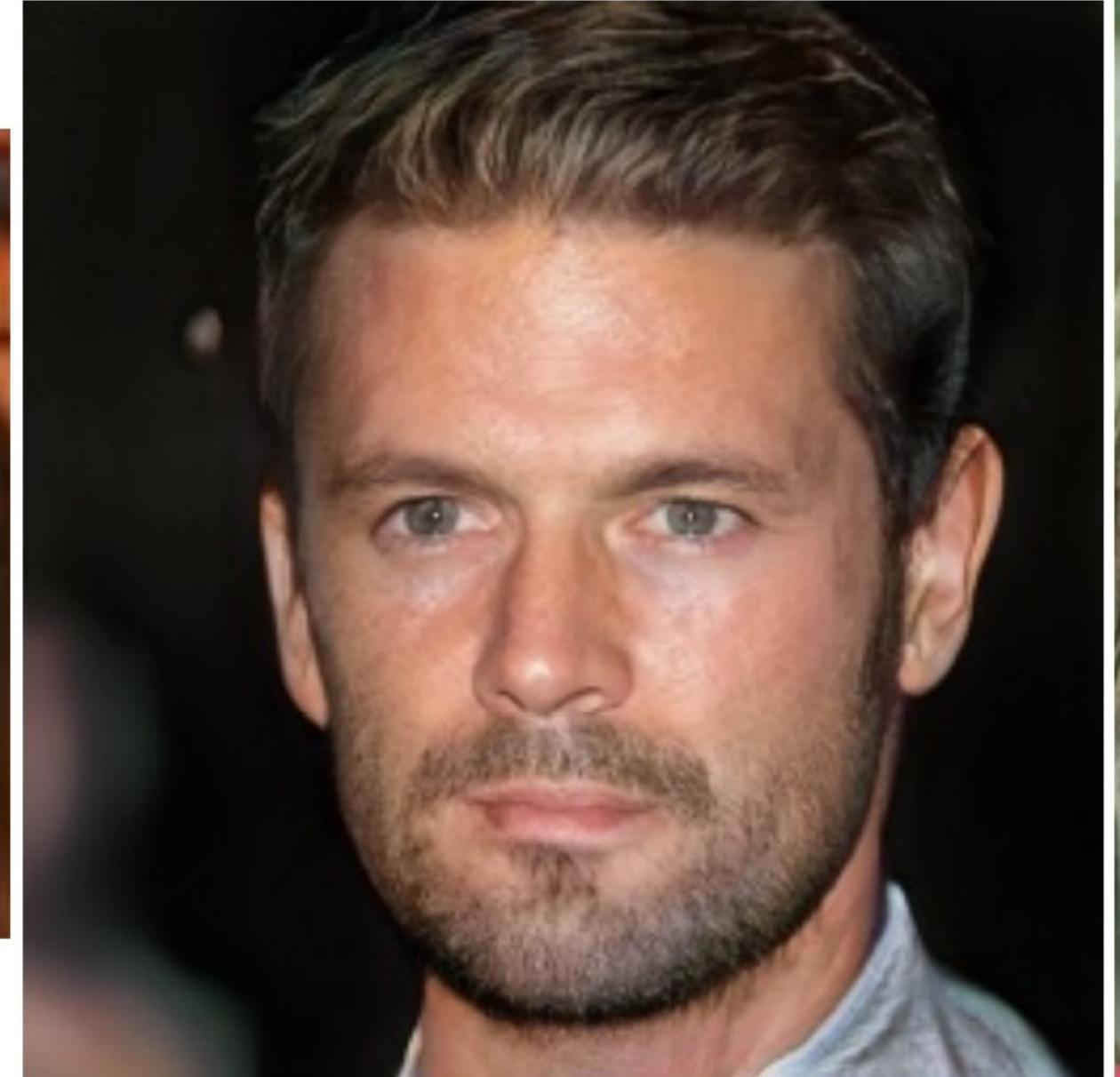
2014



2015



2016



2017



2018

# Artificial Image Synthesis

Synthesize the images



# Text to Image Generative Models

Stable Diffusion, etc.



# Machine Translation

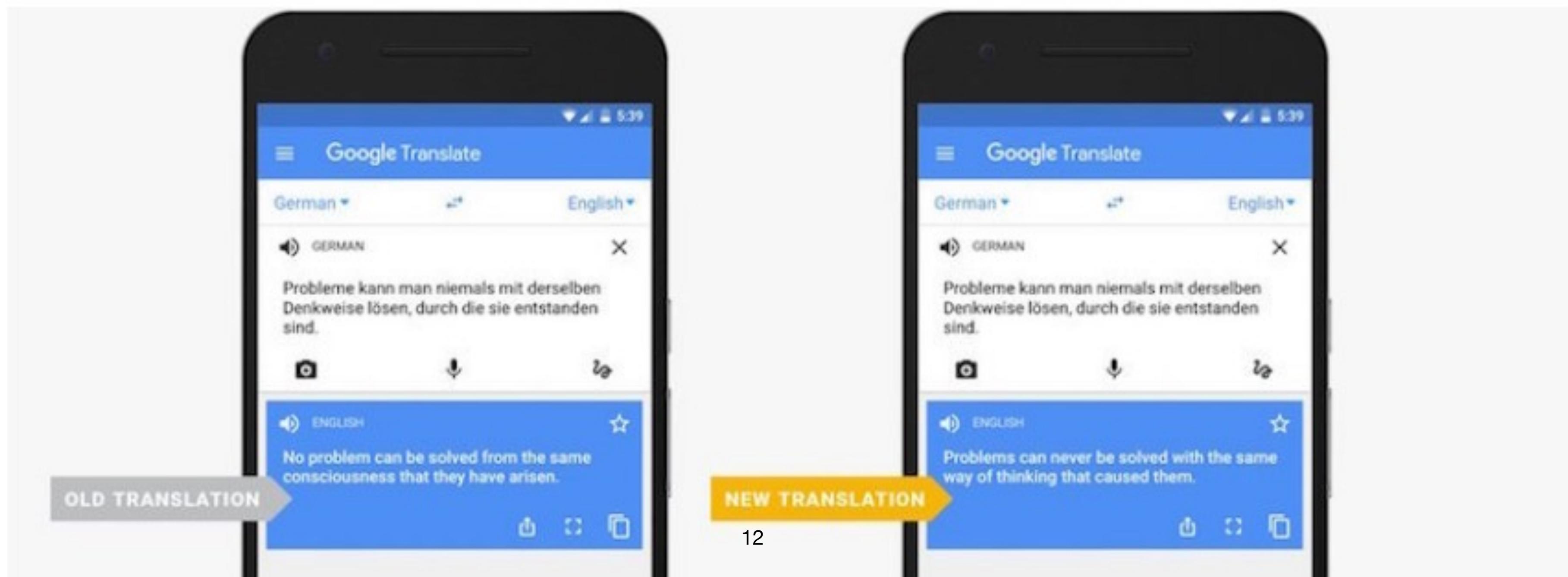
<https://www.pcmag.com/news/google-expands-neural-networks-for-language-translation>

## ***Google Expands Neural Networks for Language Translation***

The new system can translate whole sentences at a time, rather than just phrases.



By [Tom Brant](#) November 15, 2016



# Text Synthesis

**Content:** Two dogs play by a tree.

**Style:** **happily, love**



Two dogs **in love** play **happily** by a tree.



Li et al, NACCL, 2018

# Image Captioning

Human captions from the training set



A cute little dog **sitting** in a heart drawn on a sandy **beach**.



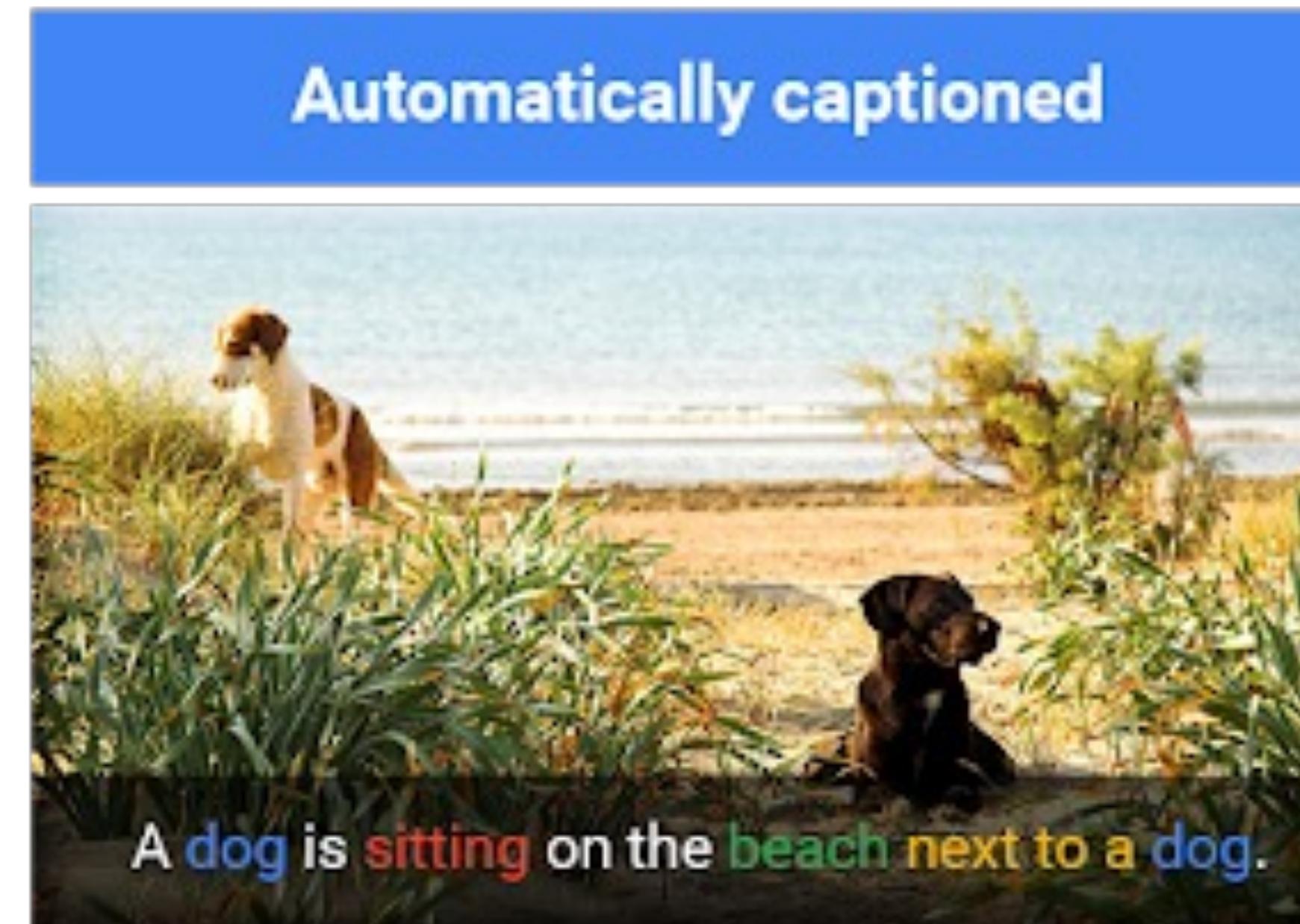
A **dog** walking **next** to a little **dog** on top of a **beach**.



A large brown **dog** **next** to a small **dog** looking out a window.



Automatically captioned



A **dog** is **sitting** on the **beach** **next** to a **dog**.

# Open AI GPT-3: Giving GPT-3 a Turing Test

**Q: What is your favorite animal?**

A: My favorite animal is a dog.

**Q: Why?**

A: Because dogs are loyal and friendly.

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**Q: What is your favorite animal?**

A: My favorite animal is a dog.

**Q: Why?**

A: Because dogs are loyal and friendly.

**Q: What are two reasons that a dog might be in a bad mood?**

A: Two reasons that a dog might be in a bad mood are if it is hungry or if it is hot.

**Q: How many eyes does a giraffe have?**

A: A giraffe has two eyes.

**Q: How many legs does a frog have?**

A: A frog has four legs.

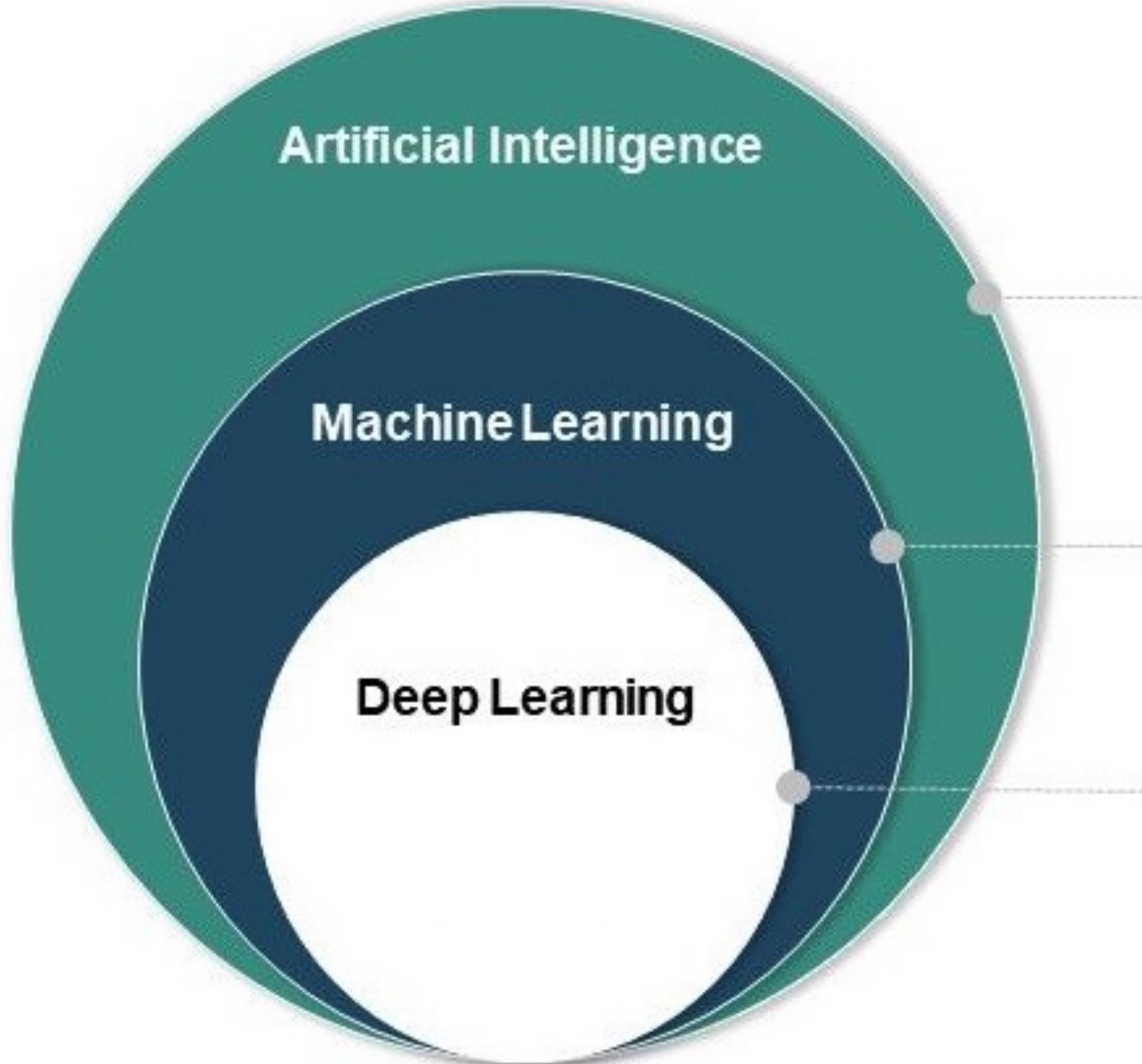
**Q: Are there any animals with three legs?**

A: No, there are no animals with three legs.

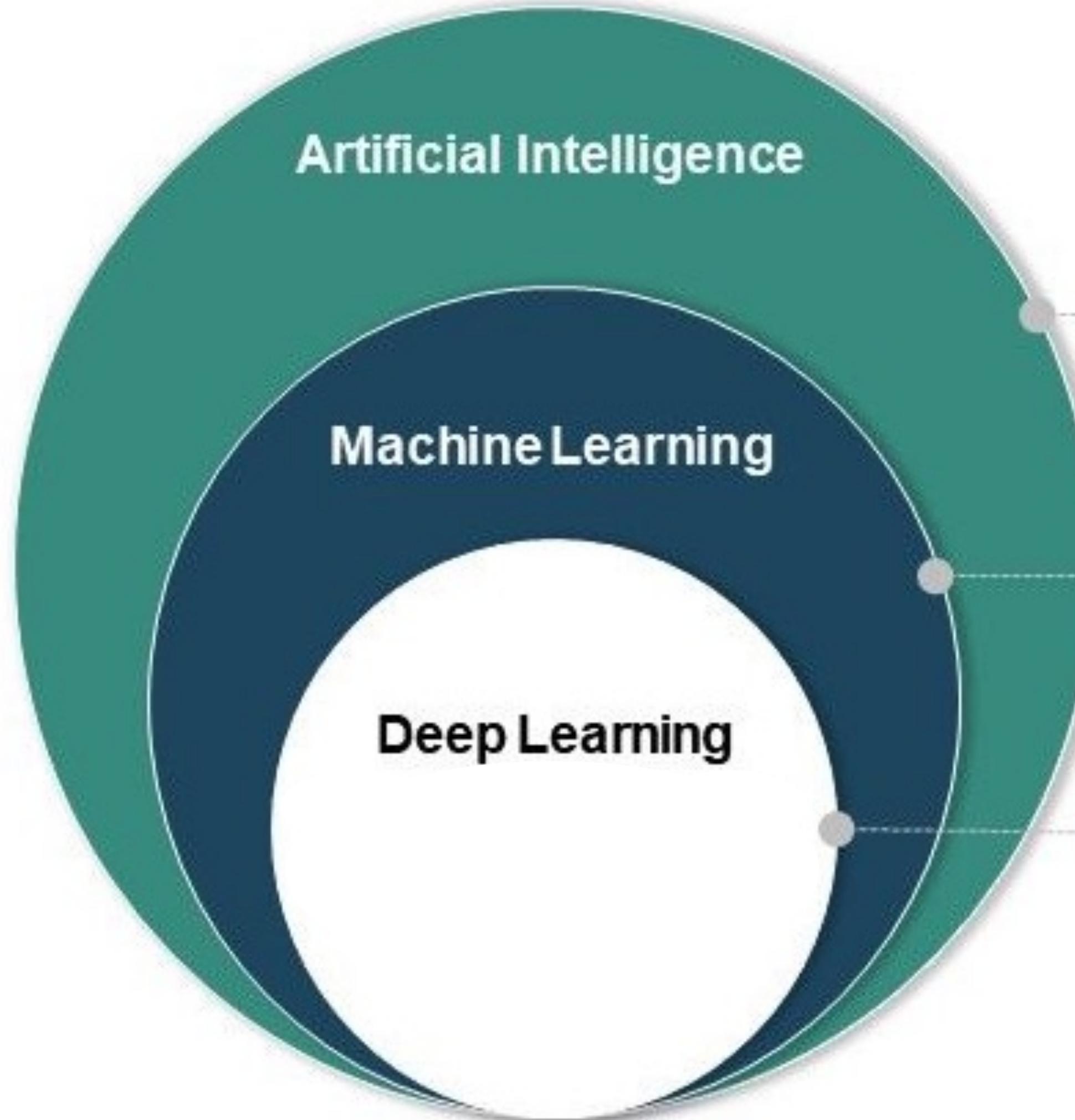
**Q: Why don't animals have three legs?**

A: Animals don't have three legs because they would fall over.

# What is Artificial Intelligence (AI)?



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## Artificial Intelligence

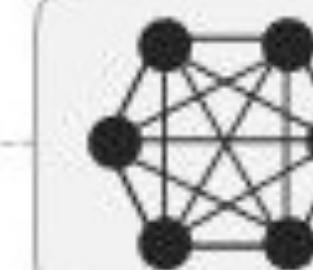
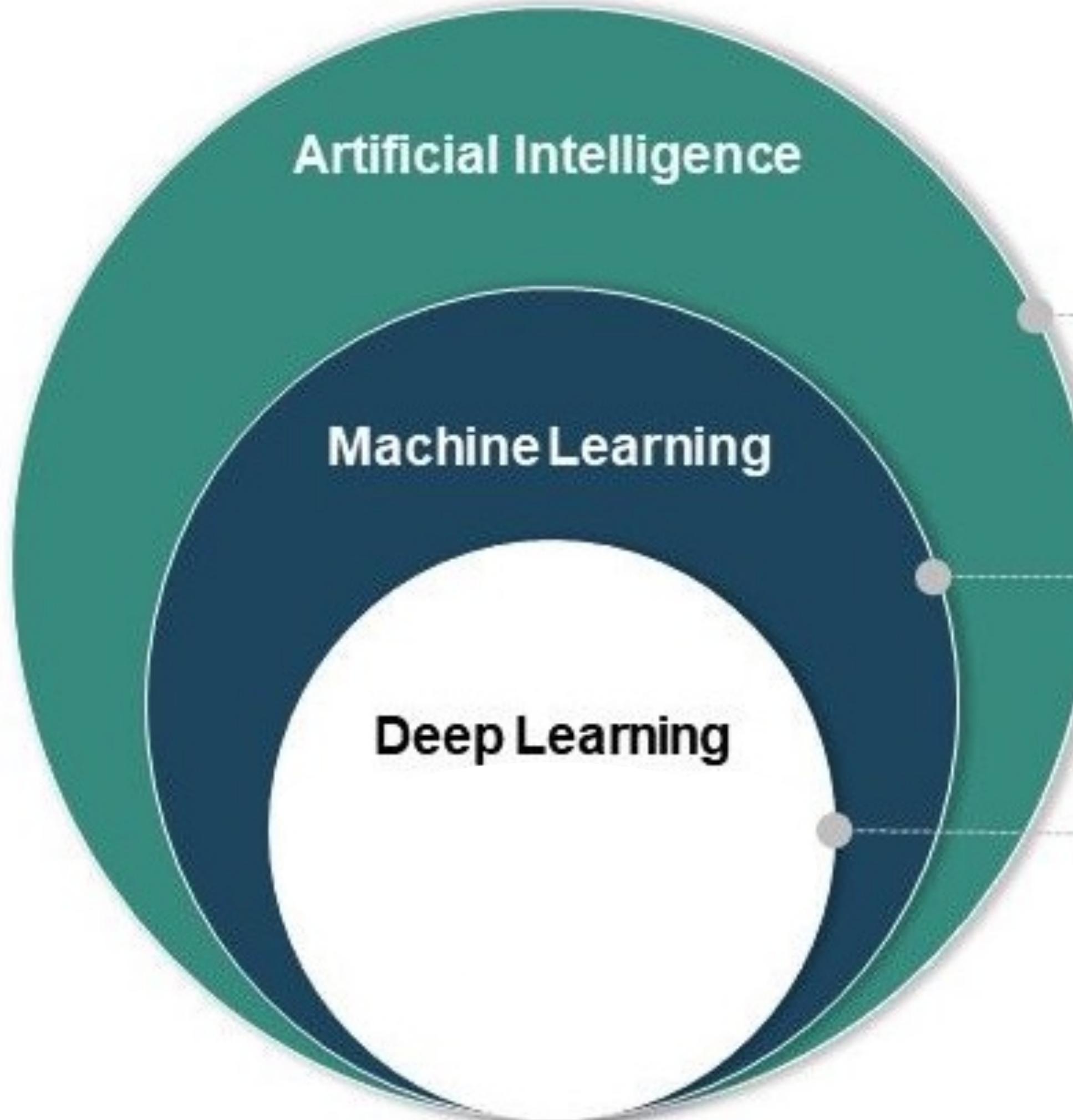
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## Machine Learning

Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

# What is Artificial Intelligence (AI)?



## Artificial Intelligence

Any technique which enables computers to mimic behavior.



## Machine Learning

Subset of AI techniques which use statistical methods to enable machines to improve with experiences.



## Deep Learning

Subset of ML which make the computation of multi-layer neural networks feasible.

# Artificial Intelligence is not Magic

They rely on **fundamental** techniques in:

- Algorithms
- Mathematics
- Logic
- Probability and Statistics
- Optimization

# What you can learn from CS540?

- Foundational tools in **Machine Learning** and **Artificial Intelligence**: Linear algebra, Probability, Logic, and elements of Statistics.
- Core techniques in **Natural Language Processing (NLP)**, including bag-of-words, tf-idf, n-Gram Models, and Smoothing.
- Basics of **Machine Learning**. supervised learning vs. unsupervised learning
- **Neural Networks and Deep Learning**: Network Architecture, Training, Backpropagation, Stochastic Gradient Descent.
- Fundamentals of **Game Theory**.
- **Search and Reinforcement Learning**
- **Artificial Intelligence and Machine Learning** in Real-World settings and the Ethics of Artificial Intelligence.

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**TL;DR Lots of useful stuff, theory and practice in AI**

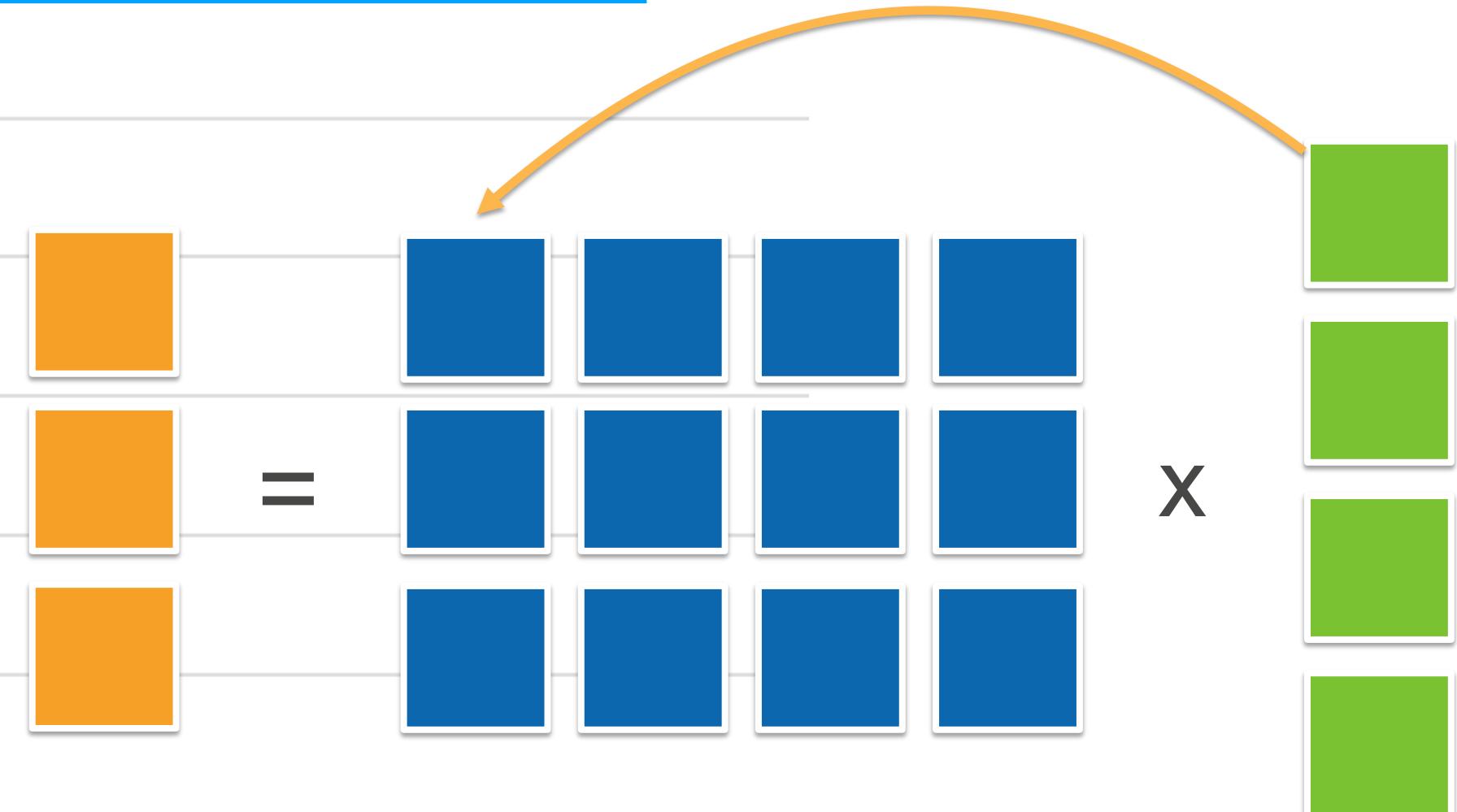
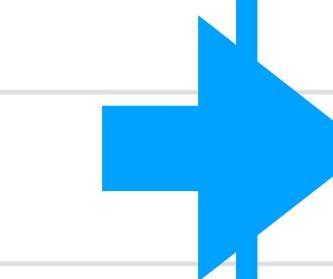
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# What you can learn from CS540?

<https://pages.cs.wisc.edu/~kandasamy/courses/22fall-cs540/schedule.html>

Date	Topic
Thursday, Sep 8	Welcome and Course Overview
Tuesday, Sep 13	Probability
Thursday, Sep 15	Linear Algebra and PCA
Tuesday, Sep 20	Statistics and Math Review
Thursday, Sep 22	Introduction to Logic
Tuesday, Sep 27	Natural Language Processing
Thursday, Sep 29	Machine Learning: Introduction
Tuesday, Oct 4	Machine Learning: Unsupervised Learning I
Thursday, Oct 6	Machine Learning: Unsupervised Learning II
Tuesday, Oct 11	Machine Learning: Linear regression
Thursday, Oct 13	Machine Learning: K - Nearest Neighbors & Naive Bayes
Tuesday, Oct 18	Machine Learning: Neural Network I (Perceptron)

**Foundations**



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**Machine learning**

# What you can learn from CS540?

Tuesday, Oct 18

Thursday, Oct 20

Tuesday, Oct 25

Tuesday, Nov 1

Thursday, Nov 3

Tuesday, Nov 8

Thursday, Nov 10

Tuesday, Nov 15

Machine Learning: Neural Network I (Perceptron)

Machine Learning: Neural Network II

Machine Learning: Neural Network III

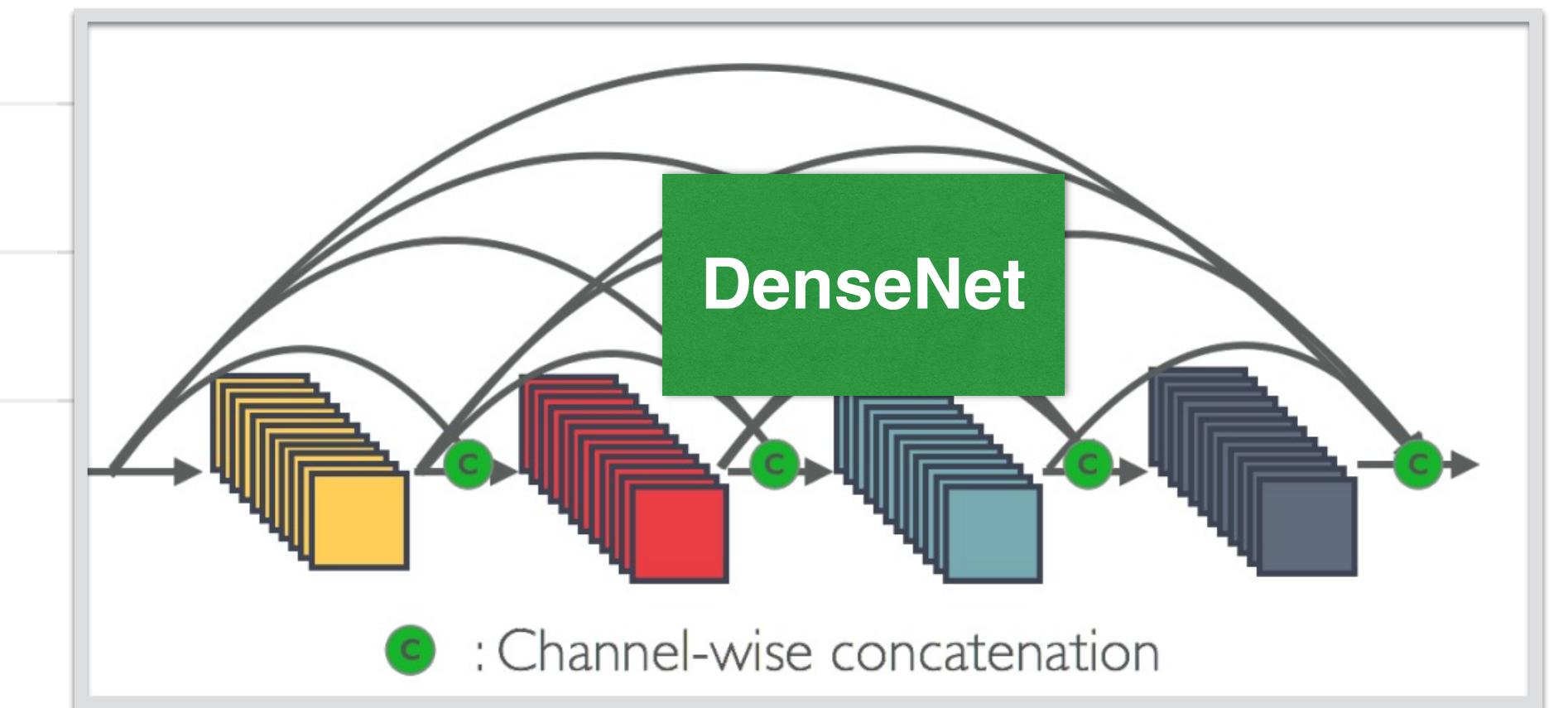
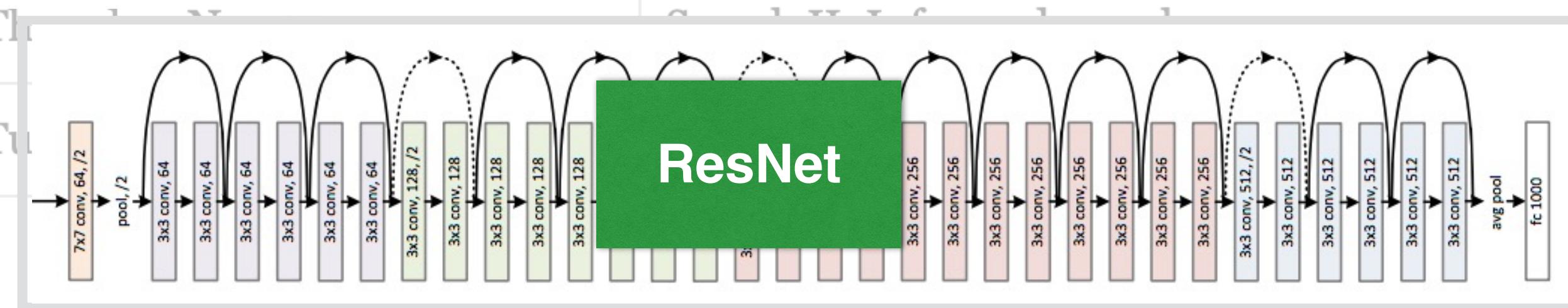
Machine Learning: Deep Learning I

Machine Learning: Deep Learning II

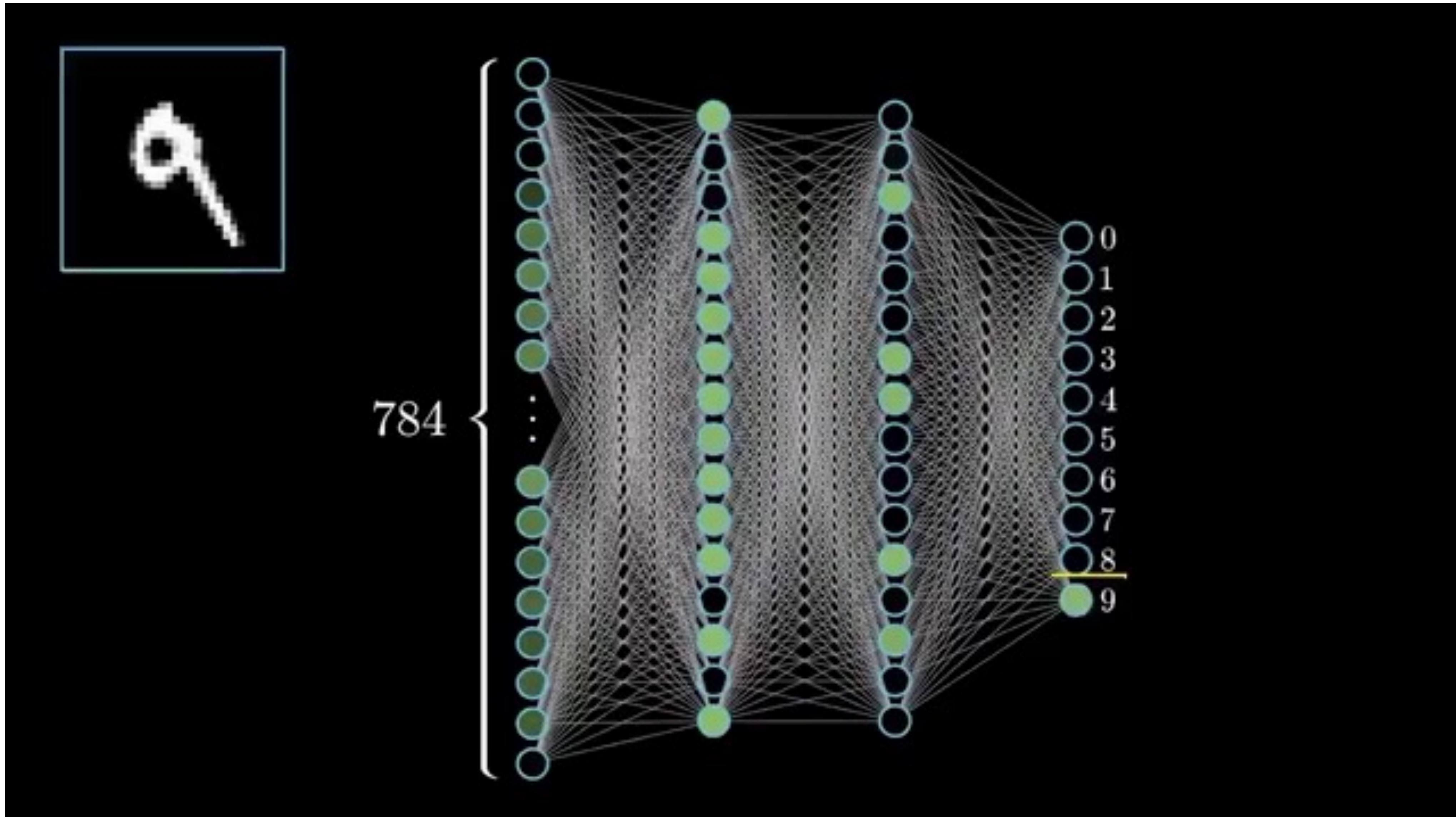
Machine Learning: Deep Learning III

Machine Learning: Deep Learning and Neural Network's Summary

Deep  
Learning



# What you can learn from CS540?



# What you can learn from CS540?

Tuesday, Nov 1

Machine Learning: Deep Learning I

Thursday, Nov 3

Machine Learning: Deep Learning II

Tuesday, Nov 8

Machine Learning: Deep Learning III

Thursday, Nov 10

Machine Learning: Deep Learning and Neural Network's Summary

Tuesday, Nov 15

Search I: Un-Informed search

Thursday, Nov 17

Search II: Informed search

Tuesday, Nov 22

Game - Part I

Tuesday, Nov 29

Game - Part II

Thursday, Dec 1

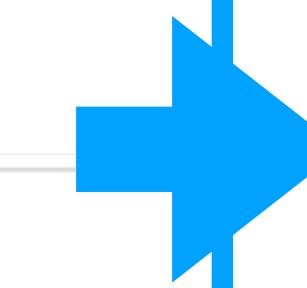
Advanced Search

Tuesday, Dec 6

Introduction to Reinforcement Learning

Thursday, Dec 8

Reinforcement Learning and Search Summary



**Game, search  
and  
Reinforcement  
Learning**

# What you can learn from CS540?

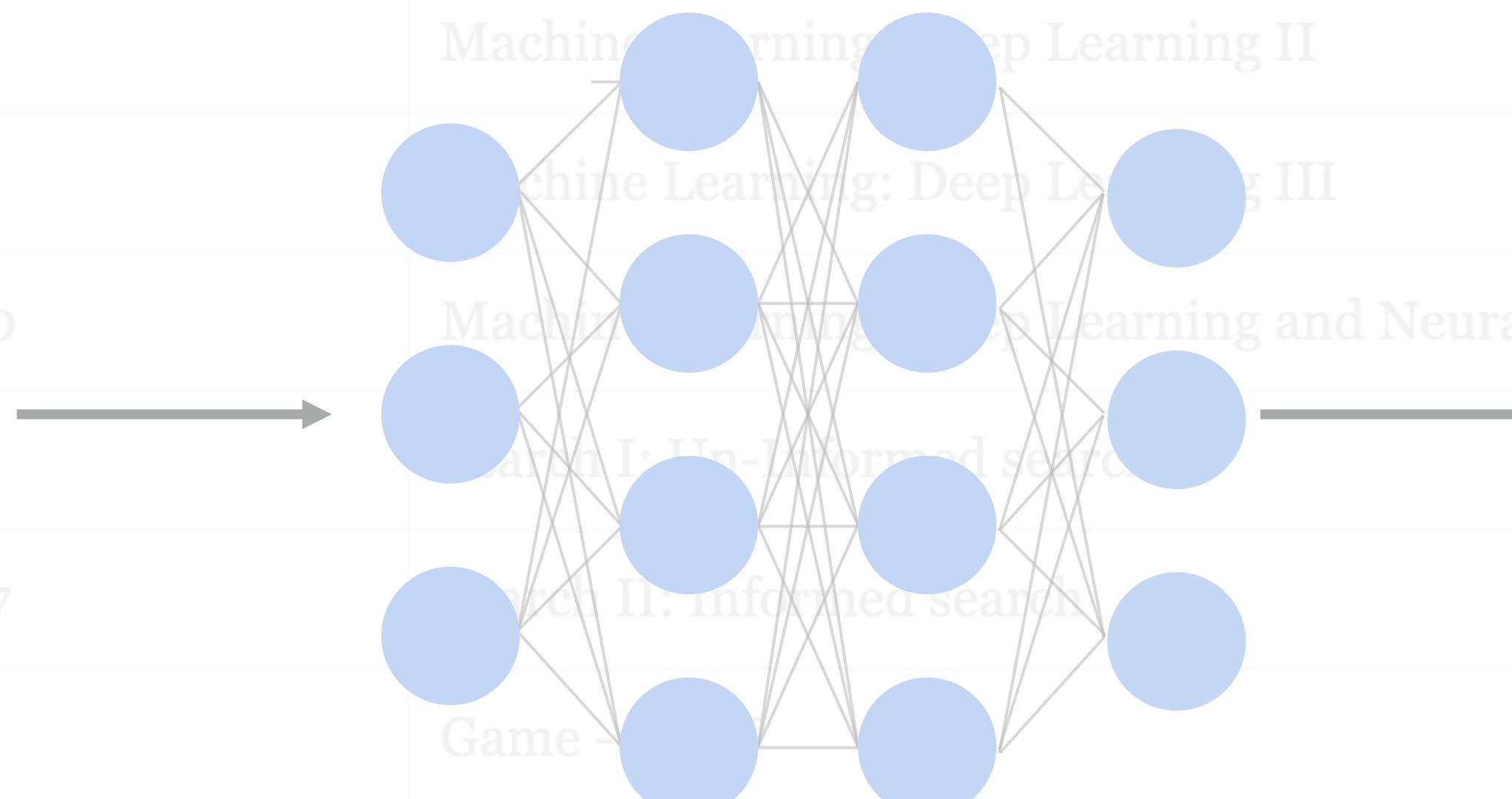
Tuesday, Nov 1

Machine Learning: Deep Learning I

Thursday, Nov 3

Machine Learning: Deep Learning II

Training Data



Tuesday, Nov 22

Machine Learning: Deep Learning III

Tuesday, Nov 29

Machine Learning and Neural Networks

Thursday, Dec 1

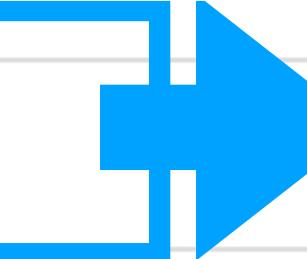
Advanced Search

Tuesday, Dec 13

Introduction to Reinforcement Learning

Reinforcement Learning and Search Summary

Ethics and Trust in AI



Real-world AI  
(new!)



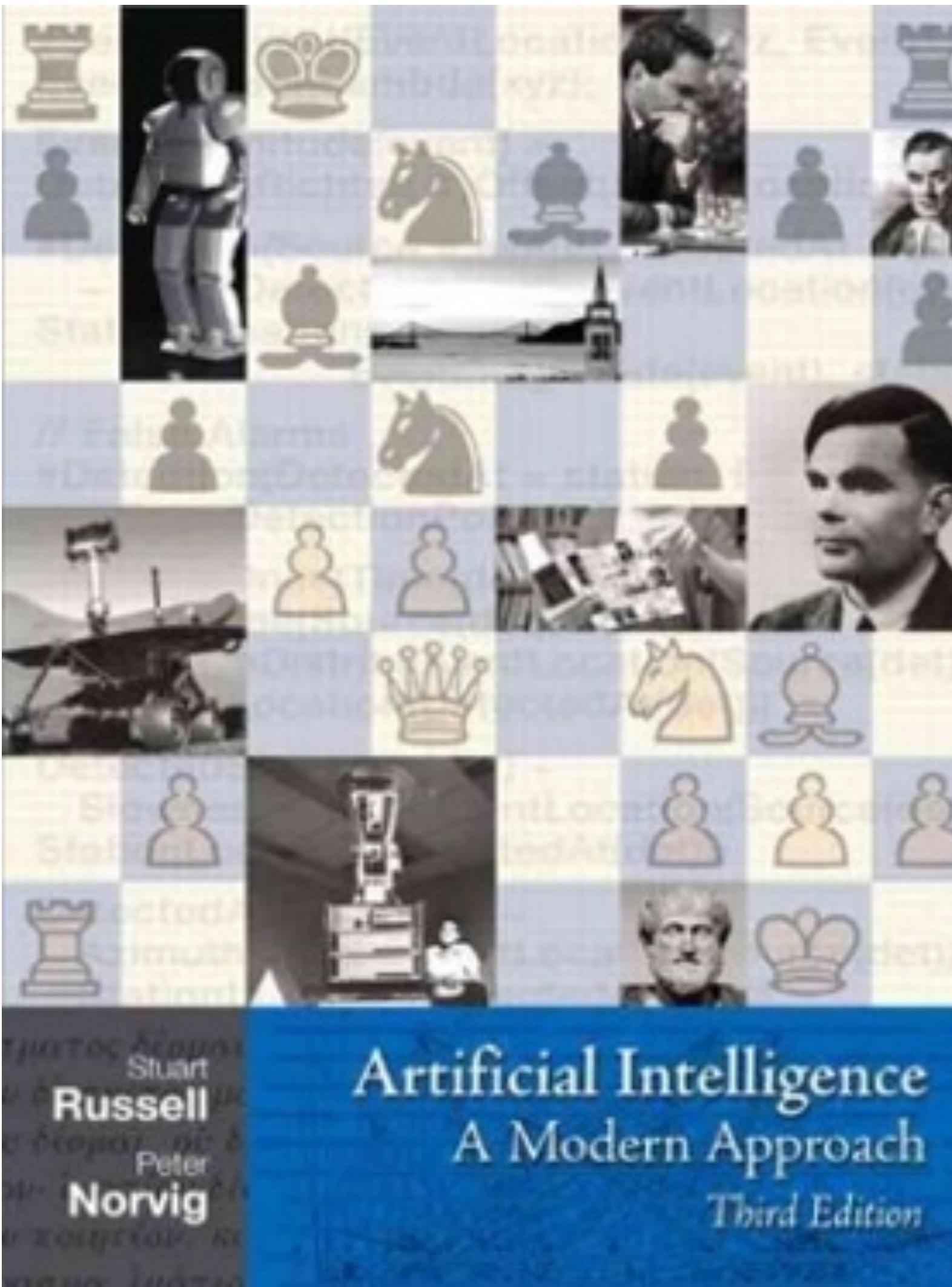
## Part II: Course Logistics

# Where to find everything?

- **Canvas** - *Pointer to everything*
  - Assignments, submissions, grades (private materials that should not be shared)
- **Course website** - public materials
  - <https://pages.cs.wisc.edu/~kandasamy/courses/22fall-cs540/index.html>
  - Slides, schedule, policies
- **Piazza** <https://piazza.com/wisc/fall2022/cs540>
  - Discussion, questions, announcements

# Textbook

Artificial Intelligence: A Modern Approach (4th edition). Stuart Russell and Peter Norvig. Pearson, 2020.  
ISBN 978-0134610993. (**textbook is optional, but may be useful**)



# Instruction Team

**(See course webpage)**

Merged across sections:

- Teaching Assistants (TAs): hold office hours, grade your homework
- Peer Mentors: hold office hours
- Graders: grade your homework

# Office Hours

- Available on the course website
- All office hours are **merged** across sections, you can go to anyone
- Use TA and Peer Mentor hours for detailed-level questions (e.g. coding related), and use professor office hours for conceptual level questions

# Grading scheme

- **Midterm Exam:** 15% (timing TBA in near future)
- **Final Exam:** 15% (TBA)
- **Homework Assignments:** 70% (10 HWs)

**TWO** lowest homework scores are dropped from the final homework average calculation.  
This is for emergency, sickness, etc.

**Homework is always due 9am on the specified date (mostly Tuesday).**  
(Late submissions will not be accepted.)

**Homework will be posted and submitted via Canvas.**

# Regrade Request

Use Google Form (will be announced) for regrade request

Raised with the TAs within 72 hours after homework / exam is returned.

# Integrity

Just don't cheat at all. You'll be caught. It's not worth it.

You are encouraged to discuss with your peers, the TA or the instructors ideas, approaches and techniques broadly. However, all examinations, programming assignments, and written homeworks must be written up individually. For example, code for programming assignments must not be developed in groups, nor should code be shared. Make sure you work through all problems yourself, and that your final write-up is your own. If you feel your peer discussions are too deep for comfort, declare it in the homework solution: "I discussed with X,Y,Z the following specific ideas: A, B, C; therefore our solutions may have similarities on D, E, F...".

You may use books or legit online resources to help solve homework problems, but you must always credit all such sources in your writeup and you must never copy material verbatim.

We are aware that certain websites host previous years' CS540 homework assignments and solutions against the wish of instructors. Do not be tempted to use them: the solutions may contain "poisonous berries" previous instructors planted intentionally to catch cheating. If we catch you copy such solutions, you automatically fail.

Do not bother to obfuscate plagiarism (e.g. change variable names, code style, etc.) One application of AI is to develop sophisticated plagiarism detection techniques!

Cheating and plagiarism will be dealt with in accordance with University procedures (see the [UW-Madison Academic Misconduct Rules and Procedures](#))

# Quiz

1. Where can I find all the 540 stuff, if I didn't write down the URL?
2. I feel sick, should I still show up to class?
3. I can't finish my homework because I was traveling, I was sick, my dog ate it, etc. Can I ask for an extension?
4. Can I do homework with a group?

# Answers

1. Where can I find all the 540 stuff, if I didn't write down the URL? Your Canvas has the main link.
2. I feel sick, should I still show up to class? NO. Study materials online.
3. I can't finish my homework because I was traveling, I was sick, my dog ate it, etc. Can I ask for an extension? No. But we discard 2 lowest hw scores.
4. Can I do homework with a group? Yes (and encouraged) for high level discussions. No for exact solutions.



## Part III: Software

# Tools



- **Python**
  - Everyone is using it in machine learning & data science
  - Conda package manager (for simplicity)
- **Jupyter**
  - So much easier to keep track of your experiments
  - Obviously you should put longer code into modules

# Python for Java Pros (slides available on website)

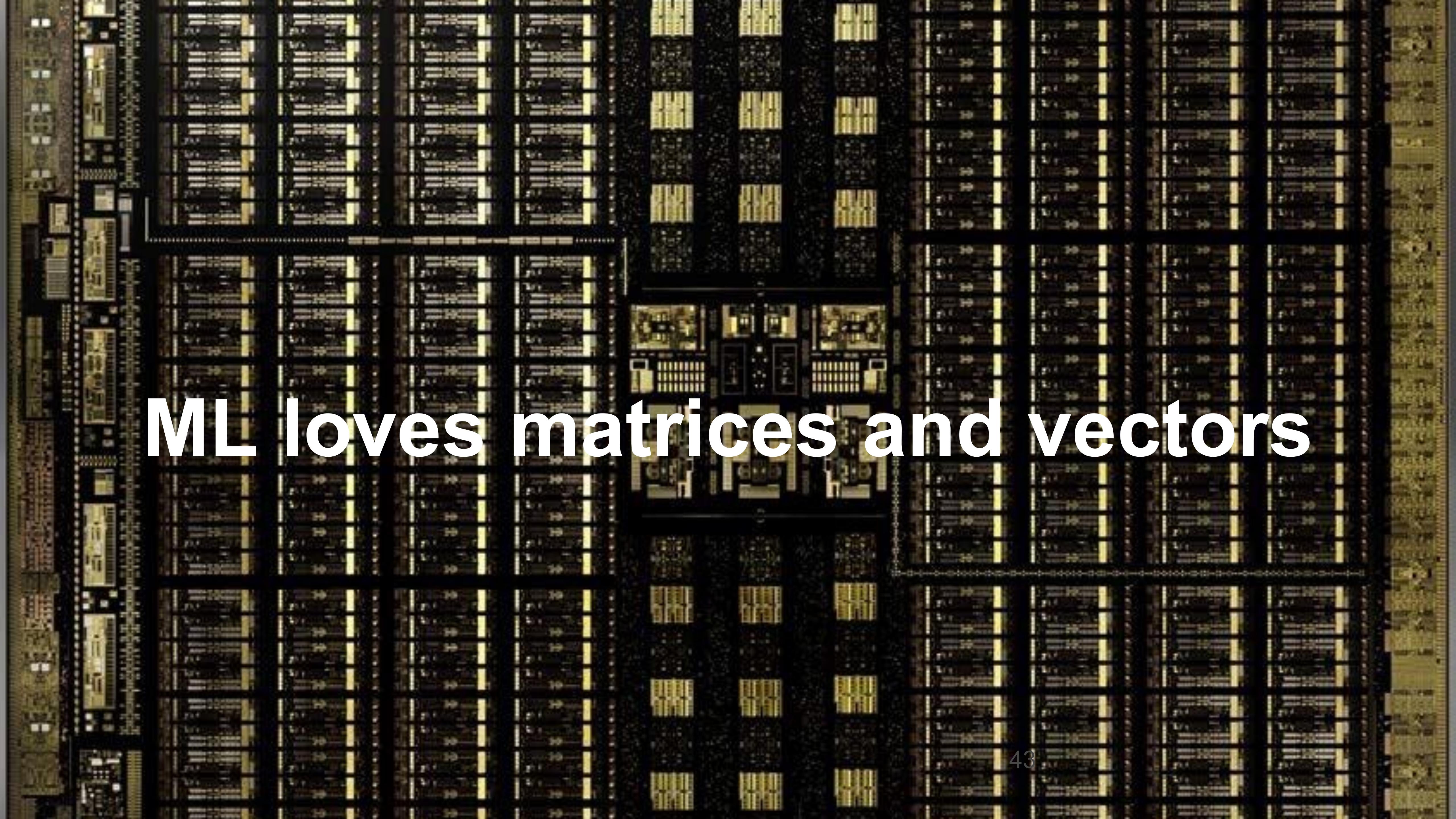
## A Crash Course in Python

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1. Why are we doing this in Python?
2. Where do I write Python code? How do I run it?
  - a. Online
  - b. Offline
3. What are the big differences between Java and Python

# Colab

- Go to [colab.research.google.com](https://colab.research.google.com)
- Activate the GPU supported runtime (this is a K80 GPU)



ML loves matrices and vectors

# Access Elements

An element: [1, 2]

	0	1	2	3
0	1	2	3	4
1	5	6	7	8
2	9	10	11	12
3	13	14	15	16

A row: [1, :]

	0	1	2	3
0	1	2	3	4
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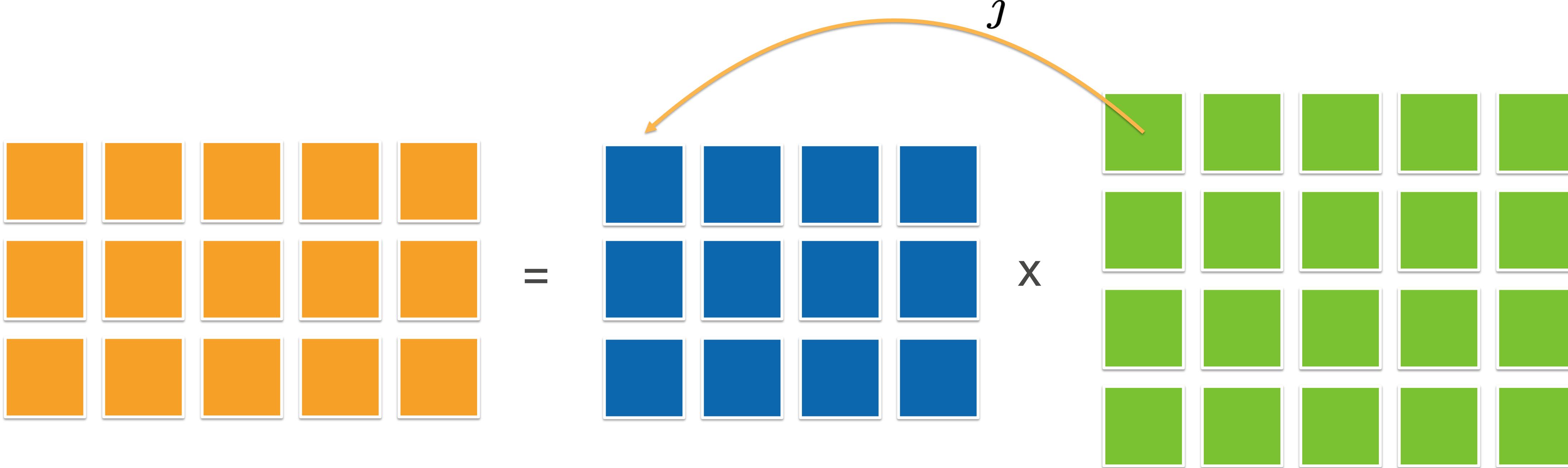
A column: [:, 2]

	0	1	2	3
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	0	1	2	3
0	1	2	3	4
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# Coming up: Probability and Linear Algebra Review

$$C = AB \text{ where } C_{ik} = \sum_j A_{ij} B_{jk}$$





# Recap

- What's in CS540
- Course logistics
- Software



**Thanks!**